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(54) RESIN COMPOSITION AND METAL-BASED CIRCUIT BOARD USING THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain an insulating adhesive composition which contains aluminium nitride and has high heat conductivity, and to provide a metal-based circuit board excellent in heat dissipation capacity which uses the same.

SOLUTION: The resin composition in which a thermosetting resin contains aluminum nitride powder the particle size of which is 10-45 μm and spherical aluminum oxide powder the maximum particle size of which is 3 μm or less, and the metal-based circuit board using the same, are provided. Heat conductivity calculated from heat resistance between surface of the circuit and reverse side of the metal board is preferably 5.0 W/mK or more.

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CLAIMS

[Claim(s)]
[Claim 1] The resin constituent characterized by the alumimium nitride powder whose particle diameter is 10-45 micrometers, and the maximum particle diameter making thermosetting resin contain spherical aluminum-oxide powder 3 micrometers or less.
[Claim 2] The resin constituent according to claim 1 with which alumimium nitride powder with a particle diameter of 10-45 micrometers is characterized by doing 50.0-80.0 mass % content of this powder and said maximum particle diameter to the whole quantity with spherical aluminum-oxide powder 3 micrometers or less.
[Claim 3] The resin constituent according to claim 1 or 2 with which alumimium nitride powder whose particle diameter is 10-45 micrometers is characterized by doing 17.0-47.5 mass % content of spherical aluminum-oxide powder 3 micrometers or less for 42.5 to 76.0 mass %, and the maximum particle diameter at an epoxy resin.
[Claim 4] The metal base circuit board which is the metal base circuit board which comes to prepare a circuit on a metal plate through an insulating layer, and is characterized by said insulating layer consisting of claim 1 and a resin constituent according to claim 2 or 3.
[Claim 5] The metal base circuit board according to claim 4 characterized by the heat conductivity computed from the thermal resistance between a circuit front face and a metal plate rear face being 5.0 or more W/mK.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Thermal conductivity of this invention is high and it relates to the metal base circuit board using an insulating adhesives constituent and it excellent in the adhesive property of a metal substrate and an insulating layer.
[0002]
[Description of the Prior Art] The adhesives of the epoxy resin system filled up with the inorganic filler on metal plates, such as aluminum, iron, and copper, from the former were applied, and the metal base circuit board which pasted up the metallic foil on it was known.
[0003] However, in these metal base circuit boards, since the thermal conductivity of the adhesives currently used as an insulating layer was low, the property of metal substrate original with sufficient thermal conductivity was not fully able to be harnessed. Then, in the property improvement of the metal base circuit board, the property improvement of an insulating adhesives constituent serves as a very important examination item on industry.
[0004] For example, as for the circuit board for semi-conductor loading used for the automobile etc., the demand of densification and a raise in mounting is increasing increasingly also about semi-conductor components, the electrical part, and also the circuit part in recent years. And by the module which mounted components, such as diode, a transistor, and IC, on these circuit boards, in order to radiate the heat generated from the circuit itself in said components list, the circuit board which is further excellent in a heat dissipation property and which has high electric dependability is demanded.
[0005]
[Problem(s) to be Solved by the Invention] Although the resin containing an inorganic filler was conventionally used for the insulating agent of the metal base circuit board, aluminum-oxide powder was mainly used as said inorganic filler. Since aluminum-oxide powder has low thermal conductivity, it cannot obtain the insulating adhesives constituent which has such high thermal conductivity that it can not necessarily be satisfied, but serves as hindrance for the metal base circuit board to be developed by the extensive application.
[0006] On the other hand, although alumimium nitride is the ingredient by which has high thermal conductivity and promising ** is carried out as said inorganic filler, since resin cannot be high-filled up with a filler, the insulating adhesives constituent of high temperature conductivity cannot be obtained, and the metal base circuit board which is excellent in the heat leakage nature with which practical use can be presented is not obtained.
[0007] As a result of examining many things in view of the above-mentioned situation, this invention person used to acquire the knowledge that resin can be high-filled up with using combining the powder of specific alumimium nitride, and specific aluminum oxide dust, a resin constituent with the high heat conductivity is obtained, and the metal base circuit board of high temperature conductivity can obtain easily using this, and used to result in this invention.
[0008]

[Means for Solving the Problem] Namely, this invention is a resin constituent characterized by the alumimium nitride powder whose particle diameter is 10-45 micrometers, and the maximum particle diameter making thermosetting resin contain spherical aluminum-oxide powder 3 micrometers or less. This powder and said maximum particle diameter receive [the alumimium nitride powder whose particle diameter is 10-32 micrometers] the whole quantity with spherical aluminum-oxide powder 3 micrometers or less preferably. It is the aforementioned insulating adhesives constituent carried out 50.0-80.0 mass % content. Still more preferably For the alumimium nitride powder whose particle diameter is 10-45 micrometers at an epoxy resin, 42.5 to 76.0 mass % and the maximum particle diameter is [spherical aluminum-oxide powder 3 micrometers or less] the resin constituents characterized by being carried out 17.0-47.5 mass % content. Moreover, this invention is the metal base circuit board produced using the aforementioned resin constituent, and is preferably characterized by the thermal conductivity computed from the thermal resistance between a circuit front face and a metal plate rear face being 5.0 or more W/mK.

[0009]

[Embodiment of the Invention] This invention is characterized by using specific alumimium nitride and specific aluminum-oxide powder as an inorganic filler in a resin constituent. That is, the maximum particle diameter mixes both with spherical aluminum-oxide powder 3 micrometers or less with alumimium nitride powder with a particle diameter of 10-45 micrometers, and the effectiveness that the metal base circuit board which has heat leakage nature high even on practical level can be supplied is conventionally acquired above the well-known metal base circuit board and an EQC by moreover making alumimium nitride powder with a particle diameter [said] of 10-45 micrometers into 50.0 to 80.0 mass % to both total quantity.

[0010] The alumimium nitride powder used for this invention is range whose magnitude of the constituent particle is 10-45 micrometers. Even if a less than 10-micrometer alumimium nitride particle exists, restoration nature may not improve and the moisture resistance of the hardening object of the resin constituent obtained may become poor. Moreover, if a bigger particle than 45 micrometers exists, whenever [restoration / of the inorganic powder at the time of filling up resin] will worsen. About the mean particle diameter of alumimium nitride powder, although it is naturally 10-45 micrometers from all particles being in said within the limits, it is desirable from it tending [much more] to attain the purpose of this invention that it is 10-32 micrometers among this range. Moreover, the alumimium nitride powder which grinds an alumimium nitride sintered compact and is obtained is desirable.

[0011] In this invention, it is characterized by the maximum particle diameter using for said specific alumimium nitride powder combining spherical aluminum-oxide powder 3 micrometers or less. In order to secure the fluidity before resin hardens at the same time it is filled up with the gap of the alumimium nitride particle which has high temperature conductivity in this invention, it improves the fill to resin and it harnesses the high temperature conductivity of an alumimium nitride particle, or in order to raise the moisture resistance after hardening, the spherical aluminum-oxide powder which consists of spherical detailed particles is chosen experimentally. If it depends on examination of this invention person about spherical extent, an aspect ratio should just be 1.2 or less. Moreover, when the particle to which the maximum particle diameter exceeds 3 micrometers is contained, whenever [restoration / at the time of filling up resin] may fall. In addition, in order to make low viscosity before hardening of the resin constituent obtained, it is so good that the particle size distribution of spherical aluminum-oxide powder are sharp.

[0012] Moreover, in this invention, this powder and the maximum particle diameter of the rate of said alumimium nitride powder are 50.0 to 80.0 mass %s to the whole quantity with spherical aluminum-oxide powder 3 micrometers or less. It is because the heat conductivity of the hardening object of the resin constituent obtained since there are few amounts of alumimium nitride powder falls, the metal base circuit board of high temperature conductivity is not obtained, whenever [restoration / at the time of filling up resin above 80.0 mass %] worsens and only the scarce metal base circuit board is obtained by electric dependability below by 50.0 mass %.

[0013] In this invention, thermosetting resin, such as an epoxy resin and polyimide resin, is mentioned

as resin. Especially, a metal plate, a metallic foil, and adhesive strength are strong, and the high epoxy resin of compatibility is preferably used for alumimium nitride. Moreover, said alumimium nitride powder and said aluminum oxide powder, and if needed, a leveling agent, a defoaming agent, a humid dispersant, a stabilizer, a hardening accelerator, etc. are added by said resin, and it is used for it surface treatment agents, such as a silane system coupling agent, a titanate system coupling agent, and an aluminates system coupling agent, and also if needed.

[0014] It sets to this invention and is desirable from the metal base circuit board which has heat leakage nature conventionally higher than the well-known metal base circuit board being obtained by thermosetting resin when 42.5 to 76.0 mass % and aluminum-oxide powder are made for alumimium nitride powder to do 17.0-47.5 mass % content of about the blending ratio of coal of said alumimium nitride powder in a resin constituent, and said aluminum-oxide powder.

[0015] Moreover, this invention is the metal base circuit board which comes to prepare a circuit on a metal plate through an insulating layer, and is characterized by said insulating layer consisting of said resin constituent. Since the insulating layer consists of thermosetting resin which contained specific alumimium nitride powder and specific aluminum-oxide powder like the above-mentioned, it is high temperature conductivity and has the description which is moreover excellent in the adhesion of a metal plate and a circuit, and is excellent in moisture resistance.

[0016] Since the thermal conductivity computed from the thermal resistance on a circuit front face and the rear face of a metal plate has the thermal conductivity of 5.0 or more W/mK, since said thermal conductivity reaches a 6.0 or more W/mK thing high price, the metal base circuit board which becomes this invention is preferably used as the circuit board of various high current applications at first, for example in the circuit board for automobile loading in an embodiment with still more desirable this invention.

[0017] As a metal plate used for this invention, although aluminum, an aluminium alloy, copper, a copper alloy, iron, stainless steel, etc. are usable, it is comparatively cheap and moreover lightweight, and since it says that it is suitable for workability or migratory devices, aluminum and an aluminium alloy are desirable. Moreover, as thickness of a metal plate, although there is especially no limit, generally 0.5-3.0mm is used.

[0018] What consists of copper, aluminum, nickel, or these compound layers is usually used that the quality of the material of the circuit in this invention should just be a conductive thing.

[0019] the approach of producing the metal base circuit board of this invention -- being related -- a metal plate top -- said resin -- applying -- hardening -- or semi-hardening is carried out and it considers as an insulating agent layer. An insulating agent layer is made into a monolayer or two or more layers at this time. Then, although spreading, hardening, or the approach of carrying out semi-hardening and sticking on a metal plate is mentioned to the approach of joining the metallic foil used as circuits, such as a copper, aluminum, or copper-aluminum compound foil, using the roll laminating method or the laminating pressing method, or the metallic foil by which circuit formation was carried out beforehand in said resin constituent, when raising the electrical characteristics of the metal base circuit boards including withstand voltage, the former approach is adopted preferably. In addition, what is necessary is just to apply a well-known approach conventionally about etching of a metallic foil in this approach.

[0020]

[Example] [Example 1] It classified from alumimium nitride powder with a commercial grain size of 45 micrometers or less, and alumimium nitride powder 70 mass % which magnitude becomes from the particle which is 10-45 micrometers, and spherical aluminum-oxide powder 30 mass % whose maximum particle diameter is 3 micrometers and the mean particle diameter of 0.8 micrometers were mixed, and the inorganic filler was produced. Next, said inorganic filler and the bisphenol female mold epoxy resin were blended so that a filler filling factor might become 90.0 mass %, and the resin constituent was further produced for the silane system coupling agent by 1 mass section (as opposed to the mixture 100 mass section of said inorganic filler and epoxy resin), and adding, respectively, stirring an amine system curing agent and a humid dispersant (big KEMI Japan, Inc. "Dis-111"), and mixing the 3.3 mass sections and the 0.3 mass sections.

[0021] On the aluminum plate with a thickness of 1.5mm, it applied so that the insulating layer thickness after hardening said resin constituent might be set to 100 micrometers, it dried and considered as B stage condition, and after that, copper foil with a thickness of 35 micrometers was placed on the insulating layer, and carried out the laminating by the pressing method, the resin constituent was stiffened, and the metal base substrate was obtained.
[0022] After carrying out the mask of the desired location by etching resist and etching copper by using a sulfuric-acid-hydrogen-peroxide mixed solution as an etching reagent about the aforementioned metal base substrate, by removing etching resist and carrying out washing desiccation, the circuit was formed and it considered as the metal base circuit board.
[0023] About the metal base circuit board obtained by said actuation, thermal resistance, withstand voltage, and the Peel reinforcement were measured. Measurement of withstand voltage is JIS. It measured based on C2110 ("TOS-8700 form" by Kikusui Electronics). Measurement of the Peel reinforcement was measured using tensilon (Oriental Baldwin, Inc. "U-1160") based on JISC-6481. Moreover, measurement of thermal resistance cut the metal base substrate in magnitude of 3.0x3.0cm, and formed the 1.0x1.5mm copper pattern by etching. On this copper foil, the TO-220 mold transistor was soldered and it fixed through heat dissipation grease on the radiation fin which carried out water cooling. Energized to the transistor, the transistor was made to generate heat, the temperature gradient on a transistor front face and the rear face of a metal plate was measured, and thermal resistance was computed. After amending the thermal resistance value of heat dissipation grease, thermal conductivity was calculated from this amended thermal resistance value.
[0024] [Example 2] Except having changed the inorganic filler in an example 1 into the rate of 10 - 45-micrometer alumimium nitride powder 60 mass % and spherical aluminum oxide powder 40 mass % whose maximum grain size is 3 micrometers, a metal base substrate and the metal base circuit board were produced by the same actuation as an example 1, and the same evaluation as an example 1 was performed.
[0025] [Example 3] Except having changed into filling factor 85 mass % of the inorganic filler in an example 1, a metal base substrate and the metal base circuit board were produced by the same actuation as an example 1, and the same evaluation as an example 1 was performed. The main production conditions and measurement result of a metal base substrate or the metal base circuit board are shown in Table 1.
[0026]
[Table 1]

	実施例 1	実施例 2	実施例 3	比較例
無機フィラーの割合（質量%） 窒化アルミニウム粉 球状の酸化アルミニウム粉	 70 30	 60 40	 70 30	 — 100
耐電圧（kV）	4.1	4.4	3.9	4.0
ピール強度（N/cm）	17.6	15.7	15.3	14.7
熱伝導率（W/mK）	7.0	5.8	5.5	4.0

[0027] [Example of a comparison] Except having changed the alumimium nitride powder in an example 1 into aluminum oxide powder, a metal base substrate and the metal base circuit board were produced by the same actuation as an example, and the same evaluation as an example 1 was performed. This result was collectively shown in Table 1.
[0028]
[Effect of the Invention] The resin constituent of this invention is using the alumimium nitride powder

of specific particle diameter, and specific aluminum-oxide powder, and resin can be high-filled up with it and it has the description from which the resin constituent hardening object which has high temperature conductivity is acquired easily. Moreover, as for the metal base circuit board of this invention, it is very useful on industry that there is the description of having 5.0 or more W/mK thing high temperature conductivity, excelling in heat dissipation nature, and excelling also in moisture resistance further, for example, it can apply to the circuit board for automobile loading etc., having a withstand voltage property more than the well-known metal base circuit board and an EQC conventionally, since said resin constituent is used.

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TECHNICAL FIELD

[Field of the Invention] Thermal conductivity of this invention is high and it relates to the metal base circuit board using an insulating adhesives constituent and it excellent in the adhesive property of a metal substrate and an insulating layer.

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PRIOR ART

[Description of the Prior Art] The adhesives of the epoxy resin system filled up with the inorganic filler on metal plates, such as aluminum, iron, and copper, from the former were applied, and the metal base circuit board which pasted up the metallic foil on it was known.
[0003] However, in these metal base circuit boards, since the thermal conductivity of the adhesives currently used as an insulating layer was low, the property of metal substrate original with sufficient thermal conductivity was not fully able to be harnessed. Then, in the property improvement of the metal base circuit board, the property improvement of an insulating adhesives constituent serves as a very important examination item on industry.
[0004] For example, as for the circuit board for semi-conductor loading used for the automobile etc., the demand of densification and a raise in mounting is increasing increasingly also about semi-conductor components, the electrical part, and also the circuit part in recent years. And by the module which mounted components, such as diode, a transistor, and IC, on these circuit boards, in order to radiate the heat generated from the circuit itself in said components list, the circuit board which is further excellent in a heat dissipation property and which has high electric dependability is demanded.

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EFFECT OF THE INVENTION

[Effect of the Invention] The resin constituent of this invention is using the alumimium nitride powder of specific particle diameter, and specific aluminum-oxide powder, and resin can be high-filled up with it and it has the description from which the resin constituent hardening object which has high temperature conductivity is acquired easily. Moreover, as for the metal base circuit board of this invention, it is very useful on industry that there is the description of having 5.0 or more W/mK thing high temperature conductivity, excelling in heat dissipation nature, and excelling also in moisture resistance further, for example, it can apply to the circuit board for automobile loading etc., having a withstand voltage property more than the well-known metal base circuit board and an EQC conventionally, since said resin constituent is used.

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(54)【発明の名称】　樹脂組成物およびそれを用いた金属ベース回路基板

(57)【要約】
【課題】窒化アルミニウムを含有する高熱伝導率の絶縁接着剤組成物とそれを用いた熱放散性に優れる金属ベース回路基板を提供する。
【解決手段】熱硬化性樹脂に粒子径が１０～４５μｍの窒化アルミニウム粉と最大粒子径が３μｍ以下の球状の酸化アルミニウム粉とを含有させたことを特徴とする樹脂組成物と、それを用いた金属ベース回路基板で、好ましくは、回路表面と金属板裏面との間の熱抵抗より算出した熱伝導率が５．０Ｗ／ｍＫ以上であることを特徴とする。

【特許請求の範囲】
【請求項１】熱硬化性樹脂に粒子径が１０～４５μｍの窒化アルミニウム粉と最大粒子径が３μｍ以下の球状の酸化アルミニウム粉とを含有させたことを特徴とする樹脂組成物。
【請求項２】粒子径１０～４５μｍの窒化アルミニウム粉が、該粉と前記最大粒子径が３μｍ以下の球状の酸化アルミニウム粉との全量に対して、５０．０～８０．０質量％含有されていることを特徴とする請求項１記載の樹脂組成物。
【請求項３】エポキシ樹脂に、粒子径が１０～４５μｍの窒化アルミニウム粉が４２．５～７６．０質量％、最大粒子径が３μｍ以下の球状の酸化アルミニウム粉が１７．０～４７．５質量％含有されていることを特徴とする請求項１又は請求項２記載の樹脂組成物。
【請求項４】金属板上に絶縁層を介して回路を設けてなる金属ベース回路基板であって、前記絶縁層が請求項１、請求項２又は請求項３記載の樹脂組成物からなることを特徴とする金属ベース回路基板。
【請求項５】回路表面と金属板裏面との間の熱抵抗より算出した熱伝導率が５．０Ｗ／ｍＫ以上であることを特徴とする請求項４記載の金属ベース回路基板。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、熱伝導率が高く、金属基板と絶縁層との接着性に優れた絶縁接着剤組成物とそれを用いた金属ベース回路基板に関する。
【０００２】
【従来の技術】従来からアルミニウム、鉄、銅などの金属板上に無機フィラーを充填したエポキシ樹脂系の接着剤を塗布し、その上に金属箔を接着した金属ベース回路基板は知られていた。
【０００３】しかし、これらの金属ベース回路基板では、絶縁層として使用されている接着剤の熱伝導率が低いため、熱伝導率の良い金属基板本来の特性を十分に活かすことができていなかった。そこで、金属ベース回路基板の特性改善において、絶縁接着剤組成物の特性改善が産業上の極めて重要な検討項目となっている。
【０００４】例えば、自動車等に用いられている半導体搭載用回路基板は、近年、半導体部品や電気部品、更に回路部分についても高密度化、高実装化の要求が益々高まっている。そして、これらの回路基板上にダイオード、トランジスターおよびＩＣなどの部品を実装したモジュールでは、前記部品並びに回路自身から発生した熱を放散するために、より一層放熱特性に優れる、高い電気的信頼性を有する回路基板が要請されている。
【０００５】
【発明が解決しようとする課題】従来、金属ベース回路基板の絶縁剤には無機フィラーを含有する樹脂が用いられるが、前記無機フィラーとして主に酸化アルミニウム粉が用いられていた。酸化アルミニウム粉は、熱伝導率が低いため、必ずしも満足できる程に高い熱伝導率を有する絶縁接着剤組成物を得ることができず、金属ベース回路基板が広汎な用途に展開されるための妨げとなっている。
【０００６】一方、窒化アルミニウムは、高い熱伝導率を有して、前記無機フィラーとして有望視される材料ではあるが、樹脂にフィラーを高充填することができないため、高熱伝導率の絶縁接着剤組成物を得ることができず、実用に供し得るような熱放散性に優れる金属ベース回路基板が得られていない。
【０００７】本発明者は、上記の事情に鑑みて、いろいろ検討した結果、特定の窒化アルミニウムの粉末と特定の酸化アルミニウム粉末とを組み合わせて用いることで、樹脂に高充填でき、熱伝導率が高い樹脂組成物が得られ、これを用いて高熱伝導率の金属ベース回路基板が容易に得ることができるという知見を得て、本発明に至ったものである。
【０００８】
【課題を解決するための手段】即ち、本発明は、熱硬化性樹脂に粒子径が１０～４５μｍの窒化アルミニウム粉と最大粒子径が３μｍ以下の球状の酸化アルミニウム粉とを含有させたことを特徴とする樹脂組成物であり、好ましくは、粒子径が１０～３２μｍの窒化アルミニウム粉が、該粉と前記最大粒子径が３μｍ以下の球状の酸化アルミニウム粉との全量に対して、５０．０～８０．０質量％含有した前記の絶縁接着剤組成物であり、更に好ましくは、エポキシ樹脂に、粒子径が１０～４５μｍの窒化アルミニウム粉が４２．５～７６．０質量％、最大粒子径が３μｍ以下の球状の酸化アルミニウム粉が１７．０～４７．５質量％含有されていることを特徴とする樹脂組成物である。また、本発明は、前記の樹脂組成物を用いて作製した金属ベース回路基板であり、好ましくは、回路表面と金属板裏面との間の熱抵抗から算出される熱伝導率が５．０Ｗ／ｍＫ以上であることを特徴としている。
【０００９】
【発明の実施の形態】本発明は、樹脂組成物中の無機フィラーとして、特定の窒化アルミニウムと特定の酸化アルミニウム粉を用いていることを特徴としている。即ち、粒子径１０～４５μｍの窒化アルミニウム粉と最大粒子径が３μｍ以下の球状の酸化アルミニウム粉との両者を混合し、しかも前記粒子径１０～４５μｍの窒化アルミニウム粉を両者の合計量に対して５０．０～８０．０質量％とすることで、従来公知の金属ベース回路基板と同等以上で実用的なレベルにまでに高い熱放散性を有する金属ベース回路基板を供給できるという効果が得られる。
【００１０】本発明に用いる窒化アルミニウム粉は、その構成粒子の大きさが１０～４５μｍの範囲である。１

０μｍ未満の窒化アルミニウム粒子が存在しても充填性が向上せず、また、得られる樹脂組成物の硬化体の耐湿性が不良となることがある。また、４５μｍより大きな粒子が存在すると、樹脂に充填する際の無機粉末の充填度が悪くなる。窒化アルミニウム粉の平均粒子径については、全粒子が前記範囲内にあることから当然に１０～４５μｍであるが、この範囲の内で１０～３２μｍであることが本発明の目的を一層達成しやすいことから好ましい。また、窒化アルミニウム焼結体を粉砕して得られる窒化アルミニウム粉末が好ましい。

【００１１】本発明では、前記特定の窒化アルミニウム粉に、最大粒子径が３μｍ以下の球状の酸化アルミニウム粉を組み合わせて用いることを特徴としている。本発明においては、高熱伝導率を有する窒化アルミニウム粒子の間隙を充填し、樹脂への充填量を向上して、窒化アルミニウム粒子の高熱伝導率を活かすと同時に、樹脂が硬化する前の流動性を確保するために、或いは硬化後の耐湿性を高めるために、球状の微細な粒子から構成される球状酸化アルミニウム粉が実験的に選択されたものである。球状の程度については、本発明者の検討に拠れば、アスペクト比が１．２以下であれば良い。また、最大粒子径が３μｍを超える粒子が含まれる場合には、樹脂に充填する際の充填度が低下することがある。尚、得られる樹脂組成物の硬化前の粘度を低くするためには、球状酸化アルミニウム粉の粒度分布がシャープなほど良い。

【００１２】また、本発明においては、前記窒化アルミニウム粉の割合は、該粉と最大粒子径が３μｍ以下の球状の酸化アルミニウム粉との全量に対して、５０．０～８０．０質量％である。５０．０質量％以下では窒化アルミニウム粉の量が少ないため得られる樹脂組成物の硬化体の熱伝導率が低下してしまい高熱伝導性の金属ベース回路基板が得られないし、８０．０質量％以上では樹脂に充填する際の充填度が悪くなり、電気信頼性に乏しい金属ベース回路基板しか得られなくなってしまうからである。

【００１３】本発明において、樹脂として、エポキシ樹脂、ポリイミド樹脂等の熱硬化性樹脂が挙げられる。特に、金属板や金属箔と接着力が強く、窒化アルミニウムとも親和性の高いエポキシ樹脂が好ましく用いられる。また、前記樹脂には、前記窒化アルミニウム粉と前記酸化アルミニウム粉と、必要に応じて、シラン系カップリング剤、チタネート系カップリング剤、アルミネート系カップリング剤等の表面改質剤、更に必要に応じて、レベリング剤、消泡剤、湿潤分散剤、安定剤および硬化促進剤等を添加されて用いられる。

【００１４】本発明において、樹脂組成物中における、前記窒化アルミニウム粉と前記酸化アルミニウム粉との配合割合については、熱硬化性樹脂に、窒化アルミニウム粉が４２．５～７６．０質量％、酸化アルミニウム粉が１７．０～４７．５質量％含有するようにするとき、従来公知の金属ベース回路基板よりも高い熱放散性を有する金属ベース回路基板が得られることから、好ましい。

【００１５】また、本発明は、金属板上に絶縁層を介して回路を設けてなる金属ベース回路基板であって、前記絶縁層が前記樹脂組成物からなることを特徴としている。絶縁層が、前述の如くに、特定の窒化アルミニウム粉と特定の酸化アルミニウム粉とを含有した熱硬化性樹脂から構成されているので、高熱伝導率であり、しかも金属板と回路との密着性に優れ、耐湿性に優れる特徴を有している。

【００１６】本発明になる金属ベース回路基板は、回路表面と金属板裏面との熱抵抗より算出した熱伝導率が５．０Ｗ／ｍＫ以上の熱伝導率を有するので、更に、本発明の好ましい実施態様においては、前記熱伝導率が６．０Ｗ／ｍＫ以上もの高値に達するので、例えば自動車搭載用の回路基板を初め、いろいろな大電流用途の回路基板として好ましく用いられる。

【００１７】本発明に用いられる金属板としては、アルミニウム、アルミニウム合金、銅、銅合金、鉄およびステンレス等が使用可能であるが、このうち比較的安価でしかも軽量で作業性や移動性機器用に好適であるという理由から、アルミニウム及びアルミニウム合金が好ましい。また、金属板の厚みとしては、特に制限はないが０．５～３．０ｍｍが一般に用いられる。

【００１８】本発明における回路の材質は、導電性のものであれば良く、通常、銅、アルミニウム、ニッケル、或いはこれらの複合層からなるもの等が用いられる。

【００１９】本発明の金属ベース回路基板を作製する方法に関しては、金属板上に前記樹脂を、塗布し、硬化或いは半硬化させて絶縁剤層とする。このとき、絶縁剤層は単一層もしくは複数層にする。その後、銅、アルミニウムあるいは銅－アルミニウム複合箔等の回路となる金属箔をロールラミネート法もしくは積層プレス法を用いて接合する方法、或いは、予め回路形成された金属箔に前記樹脂組成物を塗布、硬化或いは半硬化し、金属板上に貼り付ける方法等が挙げられるが、耐電圧を始めとする金属ベース回路基板の電気的特性を高める上で、前者の方法が好ましく採用される。尚、本方法において、金属箔のエッチングに関しては従来公知の方法を適用すれば良い。

【００２０】

【実施例】〔実施例１〕市販の４５μｍ以下の粒度の窒化アルミニウム粉より分級して、大きさが１０～４５μｍの粒子からなる窒化アルミニウム粉７０質量％と、最大粒子径が３μｍ、平均粒径０．８μｍの球状の酸化アルミニウム粉３０質量％とを混合して、無機フィラーを作製した。次に前記無機フィラーとビスフェノールＦ型エポキシ樹脂とをフィラー充填率が９０．０質量％とな

るように配合し、シラン系カップリング剤を１質量部（前記無機フィラーとエポキシ樹脂の混合物１００質量部に対して）、更にアミン系硬化剤、湿潤分散剤（ビックケミー・ジャパン株式会社「Ｄｉｓ－１１１」）をそれぞれ３．３質量部、０．３質量部を添加し、撹拌、混合することで、樹脂組成物を作製した。

【００２１】厚み１．５mmのアルミニウム板上に、前記樹脂組成物を硬化後の絶縁層の厚さが１００μmとなるように塗布し、乾燥してＢステージ状態とし、その後厚さ３５μmの銅箔を、絶縁層上に置きプレス法にて積層し、樹脂組成物を硬化させて金属ベース基板を得た。

【００２２】前記の金属ベース基板について、所望の位置をエッチングレジストでマスクして硫酸－過酸化水素混合溶液をエッチング液として銅をエッチングした後、エッチングレジストを除去し洗浄乾燥することで、回路を形成し、金属ベース回路基板とした。

【００２３】前記操作で得られた金属ベース回路基板について、熱抵抗、耐電圧およびピール強度を測定した。耐電圧の測定は、ＪＩＳ　Ｃ２１１０に基づき（菊水電子工業（株）製「ＴＯＳ－８７００形」）測定した。ピール強度の測定は、ＪＩＳＣ－６４８１に基づき、テンシロン（東洋ボールドウィン（株）「Ｕ－１１６０」）を用いて測定した。また、熱抵抗の測定は、金属ベース基板を３．０×３．０ｃｍの大きさに切断し、エッチングにより１．０×１．５mmの銅パターンを形成した。この銅箔上にＴＯ－２２０型トランジスターを半田付けし、水冷した放熱フィン上に放熱グリースを介して固定した。トランジスターに通電し、トランジスターを発熱させ、トランジスター表面と金属板裏面の温度差を測定し、熱抵抗を算出した。放熱グリースの熱抵抗値を補正した後、この補正した熱抵抗値から熱伝導率を計算した。

【００２４】〔実施例２〕実施例１における無機フィラーを１０～４５μm窒化アルミニウム粉末６０質量%、最大粒径が３μmの球状の酸化アルミニウム粉末４０質量%の割合に変更した以外は、実施例１と同じ操作で金属ベース基板、金属ベース回路基板を作製し、実施例１と同じ評価を行った。

【００２５】〔実施例３〕実施例１における無機フィラーの充填率８５質量%に変更した以外は、実施例１と同じ操作で金属ベース基板、金属ベース回路基板を作製し、実施例１と同じ評価を行った。金属ベース基板或いは金属ベース回路基板の主要な作製条件と測定結果を表１に示す。

【００２６】

【表１】

	実施例１	実施例２	実施例３	比較例
無機フィラーの割合（質量%） 窒化アルミニウム粉 球状の酸化アルミニウム粉	70 30	60 40	70 30	－ 100
耐電圧（kV）	4.1	4.4	3.9	4.0
ピール強度（N/cm）	17.6	15.7	15.3	14.7
熱伝導率（W/mK）	7.0	5.8	5.5	4.0

【００２７】〔比較例〕実施例１における窒化アルミニウム粉末を酸化アルミニウム粉末に変更したこと以外は、実施例と同じ操作で金属ベース基板、金属ベース回路基板を作製し、実施例１と同じ評価を行った。この結果を表１に併せて示した。

【００２８】

【発明の効果】本発明の樹脂組成物は、特定粒子径の窒化アルミニウム粉末と特定の酸化アルミニウム粉を用いることで、樹脂に高充填でき、高熱伝導率を有する樹脂組成物硬化体が容易に得られる特徴がある。また、本発明の金属ベース回路基板は、前記樹脂組成物を用いているので、従来公知の金属ベース回路基板と同等以上の耐電圧特性を有しながら、５．０Ｗ／ｍＫ以上もの高熱伝導率を有していて放熱性に優れ、更に耐湿性にも優れるという特徴があり、例えば自動車搭載用の回路基板に適用できる等、産業上極めて有用である。

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